

We claim:

1. A WDM optical network comprising a plurality of nodes, each node comprising an optical device at which multiplexing and/or demultiplexing operations are carried out, one or more optical amplifiers being provided between adjacent pairs of nodes, wherein a first apparatus for optical analysis is provided at the site of a first optical amplifier upstream of the first node, a second apparatus for optical analysis is provided at the site of a second optical amplifier at the downstream output of the first node, and a third apparatus for optical analysis is provided at the site of a third optical amplifier further downstream of the first node, where knowledge of the optical signal to noise ratio (OSNR) is desired, wherein the first, second and third apparatus are for measuring the signal level at frequencies both at and in-between the channel frequencies, and wherein signal levels at the channel frequencies and between the channel frequencies at the first, second and third apparatus are used to derive the OSNR at the third apparatus.
2. A network according to claim 1, wherein the change in optical signal to inter-channel noise ratio (OSINR) between the first, second and third apparatus is used to derive the OSNR at the third apparatus.
3. A network according to claim 1, wherein the optical device comprises an optical switching arrangement for the routing or forwarding of channels or groups of channels
4. A network according to claim 1, wherein each apparatus for optical analysis comprises optical spectrum analysis apparatus.
5. A network according to claim 1, wherein each optical amplifier in the network is provided with apparatus for optical analysis, and wherein the noise shaping of all nodes is determined from the apparatus for optical analysis at the amplifier sites immediately upstream and downstream of each node.
6. A network according to claim 1, wherein the amplifier sites immediately upstream and downstream of a node comprise part of the node.

7. A network according to claim 1, wherein each apparatus for optical analysis comprises a tuneable filter and a signal measurement circuit.

8. A network according to claim 1, wherein each node is provided with apparatus for
5 measuring a Q value of the optical signal.

9. A network according to claim 8, wherein the network further comprises apparatus for calculating the Q value at each amplifier site using the measured Q values at the nodes in combination the signal to noise ratios for the amplifier sites and the node sites.

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10. A method of determining the optical signal to noise ratio at a location in a WDM optical network, the network comprising a plurality of nodes comprising an optical switching arrangement for the routing or forwarding of channels or groups of channels, the method comprising:

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measuring the optical signal levels at channel frequencies and at inter-channel frequencies upstream of each node;

measuring the optical signal levels at channel frequencies and at inter-channel frequencies downstream of each node;

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measuring the optical signal levels at channel frequencies and at inter-channel frequencies at the desired location; and

determining the signal to noise ratio at the desired location using the measured values thereby taking into account the noise shaping of the nodes.

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11. A method according to claim 10, wherein the optical signal to inter-channel noise ratio (OSINR) is obtained upstream of each node, downstream of each node and at the desired location, and the signal to noise ratio is determined at the desired location using the OSINR values.

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12. A method according to claim 11, wherein the noise level at the channel frequencies is obtained by interpolating from the signal levels at the inter-channel frequencies.

13. A method according to claim 10, wherein the Q value at the location is also calculated, the calculation comprising:

measuring the Q value at the node upstream of the location;

updating the Q value using the signal to noise ratio at the node upstream of the location and the signal to noise ratio at the location.

- 5 14. An optical node for use in a WDM optical network comprising a multiplexing and/or demultiplexing device, the node including a first optical amplifier at an input to the node and a second optical amplifier at an output of the node, wherein a first apparatus for optical analysis is provided at the site of the first optical amplifier and a second apparatus for optical analysis is provided at the site of the second optical amplifier, wherein the first and second

10 apparatus are for measuring the signal level at frequencies both at and in-between the channel frequencies, and wherein outputs of the first and second apparatus are provided as outputs of the node for enabling the OSNR to be determined at a location downstream of the node, taking into account the noise shaping of the multiplexing and/or demultiplexing device of the node.
- 15 15. An apparatus for measuring the optical signal to noise ratio at a location in a WDM optical network, the network comprising a plurality of nodes, each node comprising a multiplexing and/or demultiplexing device, the apparatus comprising:

20 an input for receiving signal level data at frequencies both at and in-between the channel frequencies for locations immediately upstream and downstream of each node in the path of the optical signal and at the location at which the optical signal to noise ratio is to be measured;

a processor for processing the inputs to determine the OSNR at the location, taking into account the noise shaping of the multiplexing and/or demultiplexing device of the nodes

25 in the path of the optical signal.
16. A network management system for determining the optical signal to noise ratio at locations in a WDM optical network, the network comprising a plurality of nodes, each node comprising a multiplexing and/or demultiplexing device, the system comprising:

30 an input for receiving signal level data at frequencies both at and in-between the channel frequencies for locations immediately upstream and downstream of each node in the network and at locations at which the optical signal to noise ratio is to be measured;

a processor for processing the inputs to determine the OSNR at the locations, taking into account the noise shaping of the multiplexing and/or demultiplexing device of the nodes.

- 5 17. A computer program for carrying out a method of determining the optical signal to noise ratio at a location in a WDM optical network, the network comprising a plurality of nodes comprising an optical switching arrangement for the routing or forwarding of channels or groups of channels, the method comprising:

measuring the optical signal levels at channel frequencies and at inter-channel frequencies upstream of each node;

- 10 measuring the optical signal levels at channel frequencies and at inter-channel frequencies downstream of each node;

measuring the optical signal levels at channel frequencies and at inter-channel frequencies at the desired location; and

- 15 determining the signal to noise ratio at the desired location using the measured values thereby taking into account the noise shaping of the nodes.

18. A computer program as claimed in claim 17 embodied on a computer readable medium.